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The effect of playing formation on high-intensity running and technical profiles in English FA Premier League soccer matches

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Abstract
The aim of this study was to examine the effect of playing formation on high-intensity running and technical performance during elite soccer matches. Twenty English FA Premier League games were analysed using a multiple-camera computerized tracking system ($n = 153$ players). Overall ball possession did not differ ($P > 0.05$) between 4–4–2, 4–3–3 and 4–5–1 formations (50%, $s = 7$ vs. 49%, $s = 8$ vs. 44%, $s = 6$). No differences were observed in high-intensity running between 4–4–2, 4–3–3 and 4–5–1 formations. Compared with 4–4–2 and 4–3–3 formations, players in a 4–5–1 formation performed less very high-intensity running when their team was in possession (312 m, $s = 196$ vs. 433 m, $s = 261$ vs. 410 m, $s = 270$; $P < 0.05$) but more when their team was not in possession (547 m, $s = 217$ vs. 461 m, $s = 156$ vs. 459 m, $s = 169$; $P < 0.05$). Attackers in a 4–3–3 performed ~30% more ($P < 0.05$) high-intensity running than attackers in 4–4–2 and 4–5–1 formations. However, the fraction of successful passes was highest in a 4–4–2 ($P < 0.05$) compared with 4–3–3 and 4–5–1 formations. The results suggest that playing formation does not influence the overall activity profiles of players, except for attackers, but impacts on very high-intensity running activity with and without ball possession and some technical elements of performance.

Keywords: *Football, playing system, motion analysis, physical performance, passes*

Introduction

The physiological demands of soccer can be indirectly quantified through time–motion analysis (Bangsbo, Norregaard, & Thorsoe, 1991; Mohr, Krustrup, & Bangsbo, 2003), providing a valuable method to evaluate match performance (Rampinini, Impellizzeri, Castagna, Coutts, & Wisloff, 2008). This information can subsequently be used to develop and optimize soccer-specific physical preparation programmes (Bradley et al., 2009; Carling, Bloomfield, Nelsen, & Reilly, 2008). Interest has grown in this form of analysis over the last four decades (Bangsbo et al., 1991; Bloomfield, Polman, & O'Donoghue, 2007; Ekblom, 1986; Reilly & Thomas, 1976), with some authors suggesting that the physical, technical, and tactical demands of contemporary soccer are increasing (Andersson, Ekblom, & Krustrup, 2008; Carling et al., 2008). To accommodate for this, recent studies have determined player activity profiles in different professional leagues (English: Bradley, Di Mascio, Peart, Olsen, & Sheldon, 2010a; Italian and Danish: Mohr et al., 2003; Swedish: Andersson et al., 2008; Spanish: Di Salvo et al., 2007). Variations in performance across playing positions (Di Salvo, Gregson, Atkinson, Tordoff, & Drust, 2009) and the occurrence of fatigue in match-play (Krustrup et al., 2006b; Mohr, Krustrup, & Bangsbo, 2005; Reilly, Drust, & Clarke, 2008) have also been

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investigated. To date, no studies have examined the effect of playing formation on physical and technical performance in elite soccer. In recognition of the significant role that time–motion analysis now plays as a tool for analysing performance in elite soccer, it is necessary to examine activity patterns across a variety of popular formations to attain an expression of modern-day soccer.

Some researchers have suggested that high-intensity running distance covered during match-play is a valid measure of physical performance in elite soccer due to its strong relationship with training status (Krustrup et al., 2003, 2006a; Krustrup, Mohr, Ellingsgaard, & Bangsbo, 2005). Previous research demonstrated that high-intensity running was a distinguishing characteristic between players in different playing positions, whereby midfielders covered more distance than central defenders, full backs, and attackers (Rampinini et al., 2008). However, performance in all positions was identified by using the highly recognizable 4–4–2 formation. In addition, research suggests that high-intensity running distance is reduced towards the end of the game and temporarily after intense periods (Mohr et al., 2003). Bradley et al. (2010a) identified temporary decrements in high-intensity running during domestic and international match-play, for different playing positions and with and without ball possession. However, these studies failed to examine variations in high-intensity running according to playing formation.

Performance in soccer is a consequence of technical and tactical skills of an individual (Bangsbo, 1994). Although there is evidence to suggest that physical performance deteriorates due to match-related fatigue, few studies have examined decrements in technical performance. In a recent study, Rampinini et al. (2008) observed a decrease during match-play in several measures of technical skills, including involvements with the ball, short passes, and successful short passes. Furthermore, Helgerud and colleagues (Helgerud, Engen, Wisloff, & Hoff, 2001) reported that 8 weeks of aerobic interval training led to both improved aerobic fitness and an increase in the number of successful passes. Limited information is available about the interaction of high-intensity running patterns and technical performance in various formations. Positional roles and formations have evolved over the last few decades and physical performance has been analysed using limited formational changes (4–3–3: Reilly & Thomas, 1976; 4–4–2: Bradley et al., 2010a). An in-depth examination of high-intensity running and technical performance across formation could provide insight into position-specific changes during the game and provide a tool for optimal training preparation. Therefore, the aims of the present study were: (1) to examine the effect of formation on the physical performance of elite soccer players, in particular their high-intensity running profiles; and (2) to analyse technical performance across playing formations.

Methods

Match analysis

With institutional ethics approval and informed consent, 20 English FA Premier League games during the 2006–07 competitive season were analysed using a multiple-camera computerized tracking system (ProZone Version 3.0, ProZone Sports Ltd.®, Leeds, UK). All outfield players' movements were captured during each game by eight colour cameras (Vicon surveyor dome SVFT-W23, Oxford, UK) positioned in each of the stadiums at roof level. The data captured were analysed using match analysis software (ProZone 3 and MatchViewer, ProZone Sports Ltd.®, Leeds, UK) to produce a dataset on each player's physical and technical performance during a game. This system has been validated to verify the capture process and accuracy of the data (Di Salvo, Collins, McNeill, & Cardinale, 2006).

Game selection criteria

Originally, 70 games were included for analysis. Physical and technical performance data were collected from teams playing standard formations (4–4–2, 4–5–1, and 4–3–3). Each formation played against the most commonly used 4–4–2 formation due to insufficient numbers in other categories. Two UEFA qualified coaches observed each of the games to verify that formation was consistent throughout the game. Furthermore, care was taken by the coaches to exclude any games that involved dynamic formation transitions, as offensive formations such as a 4–3–3 can be switched to a more defensive 4–5–1 formation during a game. The number of games for 4–4–2 ($n = 7$), 4–3–3 ($n = 7$) and 4–5–1 ($n = 6$) formations was equally distributed. The games selected were played between teams of a similar placing in the league table. Teams were ranked into top, middle, and bottom and only games played between teams within each rank were analysed. Ranking was based on the end-of-season position. Games were played at the same time of day to reduce the possible influence of circadian variations on performance (Reilly & Brooks, 1986). Equal distribution of games according to home and away fixtures was ensured and the differential in score was no greater than two goals. The game outcome was similar for each of the respective formations to minimize any influence on ball possession (Lago & Martin, 2007). Thus, based on these stringent game selection criteria, the performance of 10 teams in a total of 20 matches was analysed. Data were collected

from players completing an entire match, allowing performance in 153 players in three playing positions to be profiled. Match performance was analysed for a total of 71 defenders, 48 midfielders, and 34 attackers. To ensure team and player confidentiality, all data were desensitized before analysis.

Match activities

Players' activities were coded into the following categories and speed thresholds: standing (0–0.6 km · h^{-1}), walking (0.7–7.1 km · h^{-1}), jogging (7.2–14.3 km · h^{-1}), running (14.4–19.7 km · h^{-1}), high-speed running (19.8–25.1 km · h^{-1}), and sprinting (>25.1 km · h^{-1}). The speeds for each category are similar to those employed in previous time–motion studies (Di Salvo et al., 2009; Mohr et al., 2003).

High-intensity distances

High-intensity running consisted of running, high-speed running, and sprinting (≥14.4 km · h^{-1}). Very high-intensity running consisted of high-speed running and sprinting (≥19.8 km · h^{-1}). Very high-intensity running with ball possession was defined as the very high-intensity running distance covered when the player's own team was in possession of the ball. Very high-intensity running without ball possession was defined as the very high-intensity running distance covered when the opposition team was in possession. Very high-intensity running when the ball was out of play consisted of the very high-intensity distance covered during natural breaks in the game (i.e. corners and free kicks). Peak distance covered in high-intensity running in a 5-min period represented the 5 min that contained the most high-intensity running in a game, and was specific for each player profiled (Mohr et al., 2003).

Additional match analysis measures

Mean recovery time was defined as the time that elapsed between discrete very high-intensity bouts (≥19.8 km · h^{-1}). Match analysis also included the concomitant coding of technical game events (number of passes and percentage completion rate, passes received, touches per possession, dribbles, crosses, final third entries, possession won and lost, and total ball possession) with the operation definitions in accordance with those previously employed (Andersson et al., 2008).

Inter- and intra-observer reliability

Reliability studies have previously been conducted to determine the inter- and intra-observer coefficient of variation of the present match analysis system. The inter-observer coefficients of variation for total distance covered, walking, running, high-speed running, and high-intensity running were <2%, with the exception of sprinting, for which it was 3.5% (Bradley et al., 2009). Furthermore, Bradley and colleagues (Bradley, O'Donoghue, Wooster, & Tordoff, 2007) observed good inter- and intra-observer agreement for the number and type of recorded technical events and the player and second player involved in the event ($\kappa > 0.9$).

Statistical analysis

All statistical analyses were conducted using SPSS for Windows v.14.0 (SPSS Inc., Chicago, IL). Descriptive statistics were calculated on each variable using z-scores to confirm the assumptions of normality. Three-way analysis of variance was used to explore differences between formations and examine the interaction between measures of physical and technical performance across playing positions and match halves (3 × 3 × 2 design: formation, positions, half). In the event of a significant difference, univariate analyses using Bonferroni-corrected pair-wise comparisons were employed. Statistical significance was set at $P < 0.05$. Data are presented as means and standard deviations (s) unless otherwise stated.

Results

Match distances

The total distance covered during a match was similar across formations (Table I). Greater distances were covered in walking ($P < 0.05$) in a 4–5–1 than a 4–4–2 formation. The amount of distance covered in jogging was higher ($P < 0.01$) for both the 4–4–2 and 4–3–3 formations than for the 4–5–1 formation (4290 m, $s = 620$ and 4304 m, $s = 665$ vs. 4121 m, $s = 662$). The analysis of distance covered across match halves showed no differences ($P > 0.05$) between formations (Table I).

High-intensity running profile

The distance covered in high- and very high-intensity running was similar ($P > 0.05$) in 4–4–2, 4–3–3 and 4–5–1 formations (Table I). The distance covered in very high-intensity running with ball possession in 4–3–3 and 4–4–2 formations was 32–39% higher ($P < 0.01$) than in a 4–5–1 (Figure 1). In contrast, ~19% more distance was covered ($P < 0.01$) at very high-intensity without possession in a 4–5–1 versus 4–4–2 and 4–3–3 formations (Figure 1). There were no differences ($P > 0.05$) between playing formation and distances covered at

high intensities, according to possession across game halves. No differences ($P > 0.05$) were found between formations for the total number of high-intensity bouts or for the mean recovery times between these actions (Table 1).

Table I. Physical performance according to team formation.

Variables	Formation 4–4–2 ($n = 58$)	4–3–3 ($n = 49$)	4–5–1 ($n = 46$)
Distance (m)			
Total	10697 ± 945	10786 ± 1041	10613 ± 1104
1st half	5371 ± 482	5457 ± 534	5347 ± 557
2nd half	5327 ± 514	5329 ± 539	5266 ± 641
VHI running	956 ± 302	924 ± 316	901 ± 305
1st half	475 ± 158	478 ± 160	444 ± 175
2nd half	482 ± 172	447 ± 178	457 ± 160
HI running	2633 ± 671	2649 ± 706	2585 ± 734
1st half	1330 ± 353	1375 ± 368	1311 ± 402
2nd half	1304 ± 369	1275 ± 367	1274 ± 386
Jogging	4290 ± 620*	4304 ± 665*	4121 ± 662
1st half	2178 ± 337	2206 ± 359	2114 ± 337
2nd half	2112 ± 321	2099 ± 334	2008 ± 370
Walking	3774 ± 307	3832 ± 279	3907 ± 257#
1st half	1864 ± 176	1876 ± 155	1923 ± 139
2nd half	1911 ± 160	1956 ± 142	1984 ± 149
Number HI actions	122 ± 37	120 ± 39	116 ± 40
1st half	60 ± 19	60 ± 20	57 ± 23
2nd half	62 ± 22	60 ± 21	58 ± 22
Recovery time HI (s)	50 ± 18	54 ± 25	57 ± 24
1st half	49 ± 18	51 ± 20	56 ± 30
2nd half	52 ± 23	56 ± 33	57 ± 25

Note: Data represent means and standard deviations. HI = high-intensity, VHI = very high-intensity. *Greater distance covered in 4–4–2 and 4–3–3 than 4–5–1 ($P < 0.01$). #Greater distance covered in 4–5–1 than 4–4–2.

Decrements in peak high-intensity running

The decline in peak high-intensity running immediately after the most intense 5-min period was similar ($P > 0.05$) across formations: 4–4–2 (229 vs. 117 m or 49% decline), 4–3–3 (227 vs. 113 m or 50% decline) and 4–5–1 (234 vs. 122 m or 48% decline). However, performance was reduced ($P < 0.05$) in the 5-min period immediately after the most intense 5-min period compared with the mean high-intensity distance for 5-min game periods in 4–4–2 and 4–3–3 formations (Figure 2).

Playing positions

Defenders playing in a 4–4–2 formation covered more ($P < 0.01$) total distance than defenders in a 4–3–3 or 4–5–1 formation (Table II). Attackers in a 4–3–3 formation covered 28–32% more high-intensity running ($P < 0.05$) and 22–32% more very high-intensity running compared with attackers in 4–5–1 and 4–4–2 formations (Table II). In contrast, defenders in a 4–4–2 ran ~11% more distance in high-intensity running ($P < 0.01$) than those in a 4–5–1 formation. For very high-intensity running, defenders in a 4–4–2 ran more distance ($P < 0.05$) than defenders in a 4–5–1 and 4–3–3 formation (Table II). Defenders in a 4–3–3 formation covered a greater ($P < 0.01$) total distance and distance in high- and very high-intensity running in the first compared with the second half (Table II). Attackers in a 4–5–1 formation covered less distance

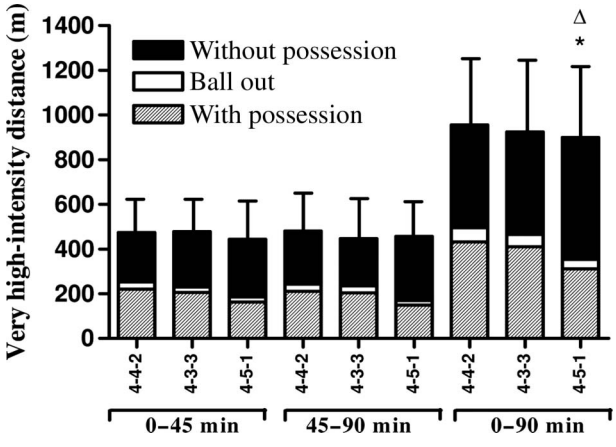

Figure 1. Very high-intensity running distance with possession of the ball, without possession of the ball, and ball out of play for various playing formations. Data represent means and standard deviations. *Distance covered with possession of the ball was lower with the 4–5–1 compared with 4–4–2 and 4–3–3 formations ($P < 0.01$). ΔDistance covered without possession of the ball was higher with the 4–5–1 compared with 4–4–2 and 4–3–3 formations ($P < 0.01$).

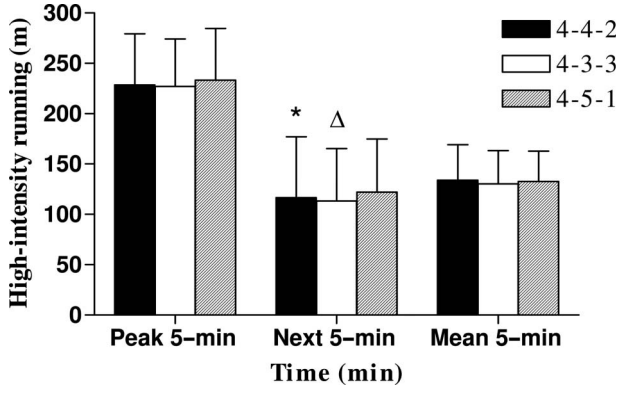

Figure 2. Peak high-intensity running distance in 5-min periods for various formations. High-intensity running in the most intense 5-min period during the game (peak 5-min), the following 5-min period (next 5-min), and the game mean 5-min period (minus the peak value) for 4–4–2, 4–3–3 and 4–5–1 formations. Data represent means and standard deviations. *Different from the mean 5-min period ($P < 0.01$). ΔDifferent from the mean 5-min period ($P < 0.05$).

Table II. Physical performance across playing position within formations.

Variables	Defenders			Midfielders			Attackers		
	4–4–2 ($n = 30$)	4–3–3 ($n = 22$)	4–5–1 ($n = 19$)	4–4–2 ($n = 18$)	4–3–3 ($n = 14$)	4–5–1 ($n = 16$)	4–4–2 ($n = 10$)	4–3–3 ($n = 13$)	4–5–1 ($n = 11$)
Distance (m)									
Total	10452 ± 755*	10073 ± 852	10123 ± 875	11505 ± 783	11586 ± 494	11606 ± 722	9982 ± 769	11130 ± 999	10012 ± 946
1st half	5221 ± 392	5123 ± 456$^{\#}$	5052 ± 519	5823 ± 343	5913 ± 287	5819 ± 324	5009 ± 355	5530 ± 487	5167 ± 447
2nd half	5231 ± 445	4950 ± 430	5071 ± 423	5681 ± 457	5673 ± 261	5787 ± 492	4974 ± 473	5600 ± 533	4842 ± 542
VHI running	862 ± 309†	751 ± 273	748 ± 293	1118 ± 262	985 ± 299	1103 ± 259	950 ± 236	1155 ± 231$^{\square}$	870 ± 227
1st half	437 ± 179	406 ± 146$^{\$}$	355 ± 159	537 ± 135	497 ± 170	535 ± 168	474 ± 94	578 ± 114	464 ± 146$^{\#}$
2nd half	424 ± 176	344 ± 160	393 ± 161	581 ± 137	488 ± 145	568 ± 137	475 ± 149	576 ± 137	406 ± 102
HI running	2454 ± 632°	2218 ± 625	2207 ± 691	3146 ± 550	3013 ± 538	3207 ± 555	2250 ± 454	2988 ± 614$^{\Delta}$	2333 ± 458
1st half	1249 ± 352	1183 ± 343$^{\$}$	1093 ± 382	1583 ± 289	1568 ± 303	1616 ± 306	1114 ± 180	1491 ± 331	1243 ± 284$^{\$}$
2nd half	1205 ± 361	1035 ± 323	1114 ± 350	1563 ± 278	1445 ± 255	1591 ± 321	1135 ± 306	1497 ± 302	1090 ± 216
Number HI actions	111 ± 37	98 ± 36	93 ± 33	146 ± 31	134 ± 28	147 ± 32	110 ± 24	142 ± 34+	108 ± 25
1st half	56 ± 21	51 ± 21	46 ± 18	70 ± 16	67 ± 17	72 ± 25	53 ± 12	67 ± 18	57 ± 18
2nd half	55 ± 22	47 ± 19	47 ± 20	76 ± 20	67 ± 13	75 ± 21	57 ± 15	75 ± 18	52 ± 13
Recovery time HI (s)	56 ± 21	67 ± 29	70 ± 28	39 ± 8	44 ± 10	41 ± 11	53 ± 11	42 ± 13	55 ± 15
1st half	54 ± 22	60 ± 23	69 ± 30	40 ± 8	43 ± 14	42 ± 14	52 ± 9	44 ± 15	52 ± 17
2nd half	58 ± 27	74 ± 41	71 ± 39	38 ± 10	43 ± 11	39 ± 11	53 ± 16	40 ± 12	58 ± 17

Note: Data represent means and standard deviations. HI = high-intensity, VHI = very high-intensity. *Defenders playing in a 4–4–2 formation ran a greater total distance than defenders in a 4–3–3 or 4–5–1 formation (both $P < 0.01$). †Defenders in a 4–4–2 formation ran greater distances than defenders in a 4–5–1 ($P < 0.01$) or 4–3–3 ($P < 0.05$) formation. $^{\circ}$Defenders in a 4–4–2 formation covered a greater distance in high-intensity running ($P < 0.001$) than those in a 4–5–1 formation. $^{\Delta}$Attackers in a 4–3–3 formation covered greater distances in high-intensity running than those in a 4–5–1 ($P < 0.05$) or 4–4–2 ($P < 0.01$) formation. $^{\square}$Attackers in a 4–3–3 formation covered greater distances than attackers in a 4–5–1 formation ($P < 0.01$). $^{+}$Attackers in a 4–4–3 formation undertook more high-intensity actions than those in a 4–5–1 ($P < 0.05$) or 4–4–2 ($P < 0.01$) formation. $^{\#}$Difference between halves ($P < 0.05$). $^{\$}$Difference between halves ($P < 0.01$).

($P < 0.05$) in high-intensity and very high-intensity running in the second half (Table II).

In possession, attackers, defenders, and midfielders in 4–4–2 and 4–3–3 formations performed more distance ($P < 0.01$) in very high-intensity running than players in a 4–5–1 formation (Figure 3). Out of possession, attackers in a 4–5–1 and 4–3–3 formation ran 37–68% more ($P < 0.01$) distance at very high intensity than attackers in a 4–4–2. Similarly, greater distances were covered at very high intensities out of possession by defenders and midfielders in a 4–5–1 ($P < 0.01$) compared with those in a 4–4–2 and 4–3–3 formation (Figure 3). Finally, analysis of the number of high-intensity runs across playing positions indicated that attackers performed more actions in a 4–4–3 compared with a 4–5–1 ($P < 0.05$) or 4–4–2 ($P < 0.01$) formation. The decline in peak high-intensity running immediately after the most intense 5-min period was more pronounced ($P < 0.05$) in midfielders in a 4–5–1 (58% decline) than a 4–4–2 formation (43% decline). Furthermore, a difference ($P < 0.05$) was observed between performance in the next 5-min and average 5-min period for midfielders playing in a 4–5–1 formation.

Technical analysis

Players in a 4–4–2 and a 4–3–3 performed more ($P < 0.01$) passes than those in a 4–5–1 formation (Table III). However, total ball possession did not differ ($P > 0.05$) between 4–4–2, 4–3–3 and 4–5–1 formations (50%, $s = 7$ vs. 49%, $s = 8$ vs. 44%, $s = 6$). A 22% reduction ($P < 0.01$) was evident in the number of passes per player in the second half compared with the first half in a 4–4–2 system. The percentage of successful passes was highest in a 4–4–2 formation ($P < 0.05$) compared with 4–3–3 and 4–5–1 formations (80%, $s = 11$ vs. 73%, $s = 13$ vs. 72%, $s = 16$). Players in 4–4–2 ($P < 0.01$) and 4–3–3 ($P < 0.05$) formations received more passes than those in a 4–5–1 formation (Table III).

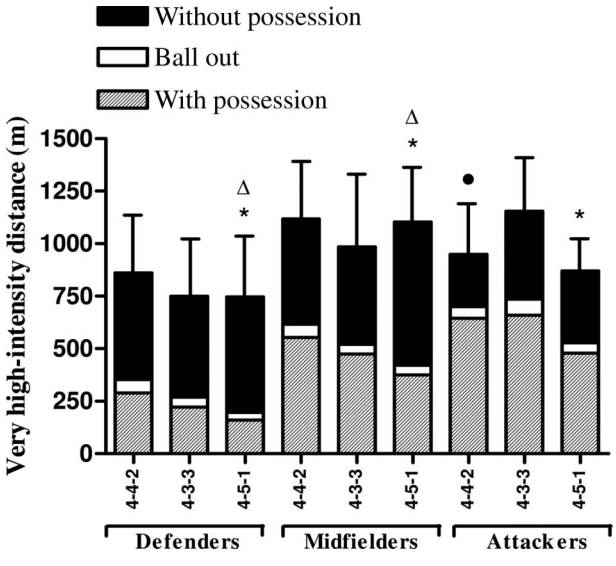

Figure 3. Positional variations in very high-intensity running distance with possession of the ball, without possession of the ball, and ball out of play in different playing formations. Data represent means and standard deviations. *Distance covered with possession was lower with the 4–5–1 compared with 4–4–2 and 4–3–3 formations ($P < 0.001$). •Distance covered without possession was lower ($P < 0.01$) with the 4–4–2 compared with 4–5–1 and 4–3–3 formations. $^{\Delta}$Distance covered without possession was higher with the 4–5–1 compared with 4–4–2 and 4–3–3 formations ($P < 0.01$).

Discussion

The present study provides a detailed investigation of the physical and technical performance of elite soccer

Table III. Technical profile according to team formation.

	Formation		
Per player	4–4–2 ($n = 58$)	4–3–3 ($n = 49$)	4–5–1 ($n = 46$)
Passes	32.1 ± 11.7	28.8 ± 16.7	21.2 ± 11.0*
1st half	18.2 ± 7.2	14.4 ± 8.4	9.9 ± 5.4
2nd half	13.9 ± 6.9$^{\#}$	14.4 ± 9.1	11.3 ± 6.8
% Successful passes	79.5 ± 10.5^{+}	73.4 ± 13.2	71.6 ± 15.5
1st half	79.7 ± 13.7^{+}	71.7 ± 19.1	71.3 ± 15.4
2nd half	79.5 ± 12.6^{+}	73.1 ± 16.4	71.5 ± 19.8
Passes received	34.3 ± 12.2	30.8 ± 18.0	24.9 ± 11.1$^{\Delta}$
1st half	19.1 ± 7.2	15.2 ± 9.5	12.1 ± 5.8
2nd half	15.2 ± 7.0	15.6 ± 10.0	12.8 ± 6.9
Touches per possession	2.5 ± 0.4	2.6 ± 0.7	2.4 ± 0.5
1st half	2.5 ± 0.4	2.6 ± 0.8	2.3 ± 0.7
2nd half	2.5 ± 0.6	2.6 ± 0.7	2.4 ± 0.6
Dribbles	0.3 ± 0.7	0.5 ± 1.2	0.4 ± 0.9
1st half	0.2 ± 0.6	0.3 ± 0.7	0.1 ± 0.3
2nd half	0.1 ± 0.3	0.2 ± 0.7	0.3 ± 0.7
Crosses	1.7 ± 2.1	1.6 ± 2.1	1.0 ± 1.3
1st half	0.8 ± 1.2	0.9 ± 1.3	0.5 ± 0.6
2nd half	0.9 ± 1.3	0.7 ± 1.2	0.5 ± 0.9
Final third entries	5.9 ± 4.0	6.3 ± 4.1	5.5 ± 3.5
1st half	3.3 ± 2.9	2.8 ± 2.3	2.7 ± 1.9
2nd half	2.6 ± 2.2	3.5 ± 2.3	2.8 ± 2.0
Possessions won	22.8 ± 11.9	21.7 ± 10.4	18.3 ± 9.9
1st half	11.4 ± 6.6	10.9 ± 5.7	9.2 ± 5.7
2nd half	11.4 ± 6.3	10.8 ± 5.7	9.1 ± 5.1
Possessions lost	21.8 ± 6.0	22.5 ± 6.7	20.8 ± 7.4
1st half	11.1 ± 3.9	11.8 ± 3.8	10.9 ± 4.2
2nd half	10.7 ± 3.7	10.7 ± 4.7	9.9 ± 4.4

Note: Data represent means and standard deviations. *Lower number of passes in the 4–5–1 than 4–4–2 and 4–3–3 formations ($P < 0.01$). $^{\Delta}$Lower number of passes received in the 4–5–1 than 4–4–2 ($P < 0.05$) and 4–3–3 ($P < 0.05$) formations. $^{\#}$Lower number of passes in the second half versus the first half with 4–4–2 formation ($P < 0.01$). $^{+}$Higher number of passes in 4–4–2 compared with 4–3–3 and 4–5–1 formations ($P < 0.05$).

players within three common playing formations. Players in 4–4–2 and 4–3–3 formations covered greater distances in jogging while players in a 4–5–1 covered more distance walking. Despite the similarity in the overall distance covered in very high-intensity running between various formations, players in a 4–5–1 formation performed less very high-intensity running when their team was in possession, but more when not in possession, compared with 4–4–2 and 4–3–3 formations. Reductions between halves also varied according to playing position, with attackers covering ~30% more very high-intensity running in a 4–3–3 formation than in 4–4–2 and 4–5–1 formations. Passing frequency was dependent on team formation, with the number of passes highest in a 4–4–2 compared with 4–3–3 and 4–5–1 formations.

The present results indicate that general match activity profiles do not differ considerably between players in three common playing formations. Irrespective of formation, players were shown to cover a similar total and high-intensity running distance. The number of high-intensity runs and recovery times between very high-intensity bouts were similar across formations, although more efforts were observed in players in 4–4–2 and 4–3–3 formations. Altogether, these findings would suggest that team formation does not impact on the overall physical demands of elite soccer match-play. Indeed, the aim of any team formation is to ensure optimal team organization so as to best utilize the physical capacities of players and reduce the efforts required to gain and use ball possession (Doucet, 2007). However, players in 4–4–2 and 4–3–3 formations covered greater distances in jogging while players in a 4–5–1 covered more distance in walking. Combined with a greater activity in high-intensity running (albeit non-significant compared with the 4–5–1), this finding suggests that players in a 4–4–2 or 4–3–3 are, to a certain extent, taxed more physically than those in a 4–5–1 formation. This difference in a 4–5–1 formation may be due to the increased number of players performing a defensive role and occupying a smaller area of play on the field.

The difference observed between formations for very high-intensity running according to ball possession is noteworthy. More distance was covered by players in very high-intensity running when their team was in possession in 4–4–2 and 4–3–3 formations compared with a 4–5–1 formation. In contrast, more very high-intensity running was performed when their team was without ball possession in a 4–5–1 formation compared with 4–4–2 and 4–3–3 formations. These differences in very high-intensity running patterns may reflect the attacking and defensive characteristics inherent to these three common playing formations. According to the coaching domain, a 4–5–1 is a more defensive system than a 4–4–2 or 4–3–3 due to the reinforcement of the midfield zones at the expense of a forward player (Bangsbo & Peitersen, 2000; Bauer, 1993). Therefore, the defensive nature of the 4–5–1 formation may lead to substantially less very high-intensity distance being covered by players when attacking and more very high-intensity running distance when defending.

Previous research has shown that the physical efforts of players are highly dependent on their positional role in the team (Di Salvo et al., 2007, 2009; Mohr, Krustrup, Andersson, Kirkendall, & Bangsbo, 2008) and that physical conditioning should therefore be position-specific (Carling et al., 2008; Di Salvo & Pigozzi, 1998). This study is the first to demonstrate that physical performance across playing positions is also dependent upon the team formation employed. Attackers within a 4–3–3 covered a greater total, high- and very high-intensity running distance than players in 4–4–2 and 4–5–1 formations. Similarly, defenders in a 4–4–2 covered a greater total and high-intensity running distance than defenders in the 4–3–3 and 4–5–1 formations. Further analysis of very high-intensity activity patterns showed that players in all positions across both 4–3–3 and 4–4–2 systems ran greater distances when their team was in ball possession compared with players in a 4–5–1 formation. In contrast, players in all positions within a 4–5–1 generally covered greater distances at very high intensities when their team was not in ball possession. Again, these discrepancies are perhaps linked to the tactical characteristics respective to the defensive and offensive nature of the three formations (Bangsbo & Peitersen, 2000). These results would suggest the need for conditioning programmes based not only on the individual position of players as suggested by Di Salvo and Pigozzi (1998), but also on the specific formation employed by the team. However, the findings should be interpreted with caution, as the small sample size only allowed a basic division into three player positions: defender, midfielder, and attacker. Recent studies have shown that the physical demands and bioenergetics across positions vary markedly according to the precise tactical role of the player (Di Salvo et al., 2009; Reilly, 1997). Defenders and midfielders in wide positions (full-backs and wide midfielders) cover more distance in high-intensity running than defenders with a central role (Di Salvo et al., 2007). Thus, more research examining the precise physical profiles within different formations of each individual positional role is necessary, specifically using a sample similar to recent large-scale analyses (Bradley et al., 2009: Di Salvo et al., 2009).

The decline in the physical efforts of elite soccer players during the second half is a consistent finding

(Carling et al., 2008). However, the present results suggest that a decline in total and high-intensity running distances is not dependent upon the formation employed by teams. In contrast, a fall in physical activity was observed in defending and attacking playing positions within the different formations. To counteract the effects of fatigue across the team, the identification of players with the most pronounced falls in work rate is prudent (Carling, Espié, Le Gall, Bloomfield, & Jullien, 2010; Clarke, Drust, MacLaren, & Reilly, 2008). Therefore, the decline in high-intensity performance between halves reported in attackers in a 4–5–1 formation is noteworthy. It has been speculated that the 4–5–1 formation places the largest physical burden on attackers, as they are often isolated and marked by several defenders (Bangsbo & Peitersen, 2000; Bauer, 1993). Nevertheless, the greater distance covered in very high-intensity running when out of possession for attackers in a 4–5–1 formation may be attributed to the physical capacity of the players and variation in task-specific requirements for each position (Bangsbo & Peitersen, 2000; Mohr et al., 2003). Attackers may be expected to pressure the back line and close down opponents when unfavourably outnumbered. The results from the present study show similarities to the observations of Mohr et al. (2003), who observed a decrease in sprinting ability in attackers towards the end of a game compared with that of defenders and midfielders. The resultant decrease in high-intensity running shown during the second half of games could be related to the aforementioned demands eliciting the onset of fatigue. Furthermore, it has been speculated that the fitness of attackers is not sufficient to meet the demands of elite European leagues (Bradley et al., 2009). In support of this, attackers were shown to perform more poorly in the game-specific Yo-Yo intermittent recovery and endurance tests (Bradley et al., 2010b; Krustrup et al., 2003, 2006a). Alternatively, such findings could be explained by attackers becoming despondent with their lack of involvement, performing more calculated decisions that reduce their exertional movement or using pacing strategies (Edwards & Noakes, 2009). Results of the present study tend to confirm this supposition, as performance was not affected in attackers when playing in 4–4–2 or 4–3–3. On the basis of this finding, teams employing a 4–5–1 formation may want to consider the strategic use of substitute attacking players during the second half of matches. However, coaches must be cautious when introducing substitutes in the latter stages of a game. Carling et al. (2010) found that incoming midfield players covered a greater total and high-intensity distance compared with their team-mates playing the full game. In contrast, attackers failed to utilize their full physical potential during the first 10 min of being introduced as a substitute compared with the equivalent time frame when starting. This may explain why certain players find it difficult to enter a game, particularly if play is away from their zonal area. As a result, coaches should carefully consider the contribution that a particular player can make and should justify introducing players dependent on the demands of the game.

The comparison of several components of technical performance between team formations revealed minimal differences, suggesting that the technical demands of match-play are common across formations. However, only a basic overview of technical performance is provided in the present study, and future work should categorize passing in relation to distance or distribution to various areas of the field to allow demarcation in the various styles of play within the same formation (direct vs. compact vs. counter-attack play). Nevertheless, despite no statistical differences in overall ball possession, the number of passes made and received was markedly higher for players in a 4–4–2 compared with 4–3–3 and 4–5–1 formations. Notably, defenders in the 4–4–2 performed a larger number of passes and other technical actions than defenders in the other formations. The aforementioned physical efforts identified in 4–4–2 defensive players combined with these greater technical requirements demonstrate the high demands placed on these players in elite soccer match-play.

Caution is needed when interpreting the findings, as a relatively small number of games were analysed, with a limited sample of players within certain playing positions. This is especially relevant given the high match-to-match variability in high-intensity running (Gregson, Drust, Atkinson, & Di Salvo, 2010). However, the low number of games was due to the stringent inclusion and exclusion criteria that controlled for time of day, home advantage, score, and standard of opposition. Furthermore, the physical and technical performance of players in other team formations employed in elite soccer (i.e. 3–5–2 or 4–2–3–1 playing formations) was not available, due to the low number of elite teams adopting these formations. Finally, this study examined performance in three common formations during games played against opponents who all employed a 4–4–2 system. However, teams will adapt their playing style during a game that is extraneous to formation and actually based on factors such as injuries, characteristics of players, and score line (Bloomfield et al., 2007). Team strategies are influenced by score line in soccer and teams employ different playing styles when ahead, level, and behind (Lago & Martin, 2007). Higher ranked teams have been shown to dominate possession over their opponents whether ahead, level or behind (Bloomfield, Polman, Butterly, & O'Donoghue, 2005)

and, therefore, an investigation into the effects on physical and technical performance when playing against higher ranked teams or teams who employ other common formations as well is merited. Researchers should also be aware of the season in which the data were collected (2006–07), since given the rapidly changing trends in contemporary soccer the data could be considered outdated.

In summary, the results suggest that playing formation does not influence the overall physical activity profiles of players. Formation did, however, impact on overall high-intensity running performance according to whether teams were with or without ball possession and some technical elements of performance. Distances covered at different intensities varied substantially for playing positions across formations. The current findings provide valuable information for managers and fitness coaches on physical and technical performance requirements across different formations and could be of use for adapting training programmes.

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